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Voice and Facsimile Section Engineering Report

DATE : September 1974

BY :

[REDACTED]

SUBJECT: Testing of Message Facsimile Equipment to Replace  
the Office Telecopier I Network

REF : Operational Requirements for Secure Facsimile  
Equipment, SED/SOD Notes

A. Purpose

As indicated in the referenced notes the existing office message facsimile network does not provide adequate service for the customers subscribing to the service. SYB has been asked to conduct tests on available facsimile machines and recommend a replacement for the existing equipment. This report describes the results of the tests performed to select a suitable replacement.

B. Background

The Agency's office message facsimile network has been in existence since about 1966. The network uses the old Magnafax Telecopiers which were acquired by Xerox and now called the Xerox Telecopier I.

These facsimiles were chosen as they were the only units which could be modified to meet the TEMPEST requirements. Currently there are [REDACTED] modified Telecopier I's in the network. Their locations are shown on Figure 1.

The most important aspects of a replacement facsimile is its interoperability with the existing secure voice systems and message facsimile units, ease of operation, and the ability to obtain a TEMPEST protected device. Other lesser requirements and desirable features are enumerated in the referenced notes. An inherent problem in facsimile is the writing stylus which operates on high voltage and in most instances produces a spark as it burns the paper with the received information.

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Most off-the-shelf office message facsimile equipment is fairly easy to use from an operational stand point. Most of the equipments have acoustical couplers and are designed for point-to-point use on the DDD commercial telephone network. Operation of the terminal only requires inserting the paper in the machine and placing the telephone handset in the acoustical coupler.

### C. Scope of Tests

An updated review of the current facsimile market was conducted and four facsimile equipments were designated for testing in an attempt to select a replacement for the existing Xerox Telecopier network. The Facilities Branch study conducted in October 1973 surveyed essentially the entire market place. No additional machines were found that could be used as replacements for the Telecopiers. As indicated in the study, there are three manufacturers who offer machines which closely meet our office facsimile requirements. These are the Xerox Model 400 Telecopier, Graphic Sciences Model dex 580 and the 3M Models VRC 600 and 603. TEMPEST tests conducted on these equipments indicate a high level of radiation and therefore requires a large controlled area for secure operation. However, the purpose of our testing was to select a replacement machine and allow OC-CS to perform additional TEMPEST tests with the objective of developing some sort of fix. If necessary, [REDACTED]

Four facsimile machines were tested for compatibility, operational usage, and readability over the secure voice network. These were the Xerox 400, 3M 600, 3M 603 and Graphic Sciences dex 580. Each machine was tested using another manufacturer's machine at the other end, to see if any problems would be encountered during a period when the new machines would be phased into the system or if more than one type of machine is used in the network. It was found that all the machines tested could "talk" to the other machines and to the existing Xerox Telecopier I's. The Graphic Sciences dex 580 has the additional capability of operating in both the AM and FM modes. The others were strictly FM.

### D. Summary of Equipment Tested

#### 1. Xerox Model 400 •

The Xerox 400 is a low volume half-duplex portable message facsimile machine which requires 4-6 minutes per page. The Model 400-1 has limited handshaking, but still works manually and has no automation. Although fairly easy to use, the

construction is only average and may not stand up under heavy use.

Limitations of the Xerox 400 are that only paper 8 1/2 by 11 inches or smaller can be used. The loading is by rotating the drum which presents some minor difficulty, also the paper is only secured on one edge causing it to flap as the drum rotates. The Xerox 400 was found to have a very strong ozone odor when receiving. In a confined space and receiving many pages, the odor could be very objectionable.

The lease cost of \$42.75 per month is high compared with other machines tested. Automatic feed is available with the Xerox 410, however, as the basic machine is the same, the 410 was not tested separately. Lease cost of the 410 is \$85.50 per month.

## 2. 3M Models VRC 600

The 3M VRC 600 is a medium volume full-duplex table top machine with special test features. The VRC 600 does not have a built-in acoustic coupler and is designed for use on a Bell System Data Access Arrangement (DAA) where it is hard-wired into the telephone system. For testing a portable acoustic coupler was used which did not perform very well.

The VRC 600 uses an electrostatic (xerographic) process rather than the electrosensitive burning method. The electrostatically charged paper is fixed with heat and produces a distinct odor which could become objectionable if a lot of papers were received over a short time period.

The VRC 600 will take 14 inch paper, but it is critical on the paper thickness. Glossy photographs and thin printer paper (TI Silent 700) did not feed properly. An automatic loader is available. The size of the VRC 600 is such that it is not readily portable and designing an RFI enclosure would be difficult due to the location of inserting paper for transmission and obtaining received copy.

The cost of \$77.60 per month is not excessive for what the equipment does, but the only average quality of the received copy, the fact we could not use the full duplex mode, and the problems encountered in testing as mentioned earlier definitely puts the VRC 600 in an unfavorable category.

### 3. 3M Model VRC 603 Portable Remote Copier

The 3M VRC 603 is a medium volume half-duplex portable message facsimile. The unit can operate at three, four and six minutes per 11 inch page. The 603 uses FM and has a self-test capability which puts lines on a sheet of facsimile paper to check the receive section.

The 603 equipment is manufactured in Japan and has a plastic case. The paper for transmission or reception is placed on the rotating drum and clamped in place. In operation the printing process produces an unpleasant odor. However, it is not as objectionable as with some other units tested. The 603 does not have any handshaking with the distant end.

The VRC 603 will take paper up to 8 1/2 by 11 inches. It has a built-in acoustic coupler for direct use over the dial telephone. Operation is straight forward and a buzzer sounds when the copy is completed.

An additional option available for the VRC 603 is the use of a battery pack for completely portable use. This could be used on a car radio phone for instance.

The monthly lease cost of the VRC 603 is \$38.80, which is the lowest of the units tested. Purchase price in quantities of one to nine is \$1,546.30 each.

### 4. Graphic Sciences dex 580

The dex 580 is a medium volume half-duplex portable message facsimile device. The dex 580 is one of a series of Graphic Sciences dex message facsimile equipments. The dex 580 unit is capable of three and six minute AM for good resolution copy between other dex facsimiles and six minute FM for interconnecting with standard FM facsimiles.

The dex 580 is built with a metal case and has a slide out tray for ease of loading. The unit has positive control of both transmission and reception and provides for handshaking with other dex facsimiles. Due to the positive control, the operation is not as direct as some units tested, however, once the operation is known, it is not much more difficult than the simplest of machines.

The dex 580 has a built-in acoustic coupler with a sound-proof cover that reduces ambient noise and related interference. Other dex units are designed for use with a Data Access Arrangement, thereby, eliminating the acoustic coupler.

The dex units will accept paper up to 9 by 14 inches. Although an odor is developed when receiving copy, it is significantly reduced by a built-in charcoal filter.

Monthly lease of the dex 580 is \$75.00 and the purchase price is \$3,680.00. These are the highest prices for portable facsimile machines tested. However, the benefits and advantages of the dex 580 are significant over the other portable machines.

Other versions of the dex family of equipments are the dex 585 and 185 which do not have built-in acoustic couplers. These are designed for hard wired installations. The dex 585 unit could be used inside  to eliminate a double 25X1 acoustic coupler requirement. The dex 180 and 185 do not have the FM mode for compatibility with other types of facsimiles.

#### E. Test Results

Since these facsimile machines would be used over the secure voice network, tests were conducted using the Green phone system and between the Green and Gray systems. All tests were successful. Little or no degradation was encountered when using the secure phone system versus use on the Black telephone system.

Operational evaluation turned up some difficulties, however, the Xerox 400 machine secures the paper only on one end which allows the paper to flap around the drum. The paper used with this machine also has the strongest odor. It should be pointed out that three of the machines tested use the electrosensitive or burning method. The 3M 600 uses an electrostatic (xerographic) printing process, however, it still has an unpleasant odor when printing. The 3M Model 603 uses a paper which has less odor and the Graphic Sciences machine uses a charcoal filter to provide an almost odor-free process.

The 3M Model 603 and the Xerox Model 400 require the drum to be rotated then the paper inserted. For loading this is not as straight forward as it seems. The 3M Model 600 uses a front loading process which seems easier, however, due to paper thickness the mechanism sometimes doesn't pull the paper entirely into the machine. The easiest loading process is with the Graphic Sciences

machine. The paper is laid into a tray which is then pushed into the machine.

Graphic Sciences Model dex 580 has some additional hand-shaking features which provide stopping the machines from either end and eliminating the procedure of waiting for a tone from one end before starting the machine on the other end. Of the four machines tested Graphic Sciences Model dex 580 provides the easiest loading, the best copy, the fastest speed and the overall rugged appearance of a well built machine.

Although all of the facsimiles tested provided acceptable quality some were definitely better than others. Table 1 is a compilation of the technical aspects of the facsimile equipment tested. The Xerox Model 410 and the Graphic Sciences dex 180 were not tested as they are identical in operation to their comparison equipments which were tested. These are shown for comparison only.

Sample copies received are shown on Figures 2 through 6. Figure 2 is copy received on the existing Telecopier I network. Figures 3 through 6 are received copy from the Xerox 400, 3M 600, 3M 603 and Graphic Sciences dex 580 facsimile machines. Each of these copies were transmitted at 6 minutes per page. For comparison, Figures 7 and 8 show copy received on the 3M 603 and Graphic Sciences dex 580 and 3 minutes per page.

Tests showed copy from the 3M VRC 603 at 3 minutes have less resolution and was lighter than in the 6 minute mode. Copy from the dex 580 was comparatively the same for both the 3 minute and 6 minute mode. Both machines show promise for use at 3 minutes per page each receiving good quality copy.

Additional tests were performed with the dex 580 operating over a narrowband channel vocoder (HY-2 to VADAC III) circuit. Results using acoustic coupling in both AM and FM modes proved worthless. One of the main problems is the lack of pitch information from the single carrier frequency put out by the facsimile modem. The best way around this would be to obtain the digital signal prior to analog conversion and route it to the digital output of the channel vocoder. Additional tests will be required to determine the feasibility of this approach.



TABLE I  
OFFICE FACSIMILE EQUIPMENT

	XEROX 400-1	XEROX 410	3M 600	3M 603BBG	Graphic Sciences dex 580	Graphic Sciences dex 180
Monthly Lease (Maint. incl.)	43.65	87.30	77.60	49.16	75.00	75.00
One-time In- stallation charge	10.00	25.00	15.00	10.00	12.50	12.50
Paper Size	8-1/2 x 11 Sheet	8-1/2 x 11 Sheet	8-1/2 x 14 Roll	8-1/2 x 11 Sheet	9 x 14 Sheet	9 x 14 Sheet
Acoustic Coupler	Built in	Built in	Optional	Built in	Built in	Built in
Writing Method	Electro- sensitive	Electro- sensitive	Electro- static	Electro- sensitive	Electro- sensitive	Electro- sensitive
Speeds (Min/mode)	4/6 FM	4/6 FM	4/6 FM	3/4/6 FM	6-FM 3/6 AM	3/6 AM
Odor	High	High	Slight	Medium	Filtered	Filtered
Document Loader	No	Yes	Optional	No	Single page Built in	Single page Built in
TEMPEST	All Bad	-----	-----	-----	-----	-----

Purchase Price	\$1,567.50	Not Available	\$3,003.30	\$1,737.60	\$3,680.00	\$3,200.00
		Not tested as operation similar to Model 400				Not tested as operation simi- lar to dex 508



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F. Conclusions

Based on the results of testing the above mentioned facsimile equipments only two machines were determined to have the capability for sending message copy with adequate quality and resolution. These are the 3M VRC 603 and the Graphic Sciences dex 580.

Overall the Graphic Sciences dex 580 proved to provide the best quality. The ability to use either 3 or 6 minutes AM and 6 minutes FM is attractive. The dex 580 was just as easy to use as the other portable machines and the positive control afforded by the Transmit, Stop and Receive controls made for essentially trouble-free operation. Table 2 is a compilation of the benefits available with the dex 580 which are not all available on the other machines tested.

Although the dex 580 leases for \$75.00 per month this amounts to only \$245 per year additional cost over the existing Telecopier I units. Conversion of the Telecopier I network to dex 580 will cost the Agency approximately \$5,000 more per year. It is anticipated that once good quality facsimile equipment is in the inventory the requirement for facsimile units will greatly increase.

G. Recommendations

It is proposed that a Graphic Sciences dex 580 and a 3M VRC 603 facsimile be procured and submitted to Communications Security for complete TEMPEST testing. It is anticipated that some sort of fix can be developed that will allow reduction of the security control zone so that as a minimum [redacted] will not be needed in the Headquarters building.

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Further it is recommended that upon completion of the TEMPEST tests all offices with Telecopier I's be requested to lease the Graphic Sciences dex 580 or 3M VRC 603 and terminate the lease of their Telecopier I's.

An additional requirement is to have these two facsimiles tested to determine the difficulty in obtaining a digital output which could be used on AVD circuitry.

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TABLE 2

Features of the Graphic Sciences dex 580 Facsimile

The following items are available only on the Graphic Sciences dex 580 type facsimile equipments.

1. Accepts paper up to 9 x 14".
2. Has charcoal filter to reduce odor to acceptable level.
3. Has flat bed loading drawer for operator convenience.
4. Has enclosed drawer for acoustical coupler for reduction of incidental noise into transmission.
5. Has positive control action via Receive, Transmit and Stop buttons.
6. Has capability of 3 minute AM mode for working with other dex machines. This reduces distortion and has good linearity.
7. Has capability of starting or stopping anywhere on the page.
8. Has metal case for improved physical protection.
9. Has adjustable indices provided to allow sending only desired portions of documents thereby reducing transmission time.

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